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COMPUTER AIDED SHIP DESIGN

By Robert H. Owens

27 August 1971

UNITED STATES OF AMERICA

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COMPUTER AIDED SHIP DESIGN

As assignment to look at computers in shipbuilding was accepted enthusiastically. I had been associated with shipbuilding off and on for a period of 17 years prior to 1961, and in 1959 had written a program for the Posrtsmouth Naval Shipyard computer which provided coordinates to be plotted by the loftsmen on the mold loft floor from which they could lay-off full size cross-sectional curves for a rather difficult submarine conversion. The loftsmen, at first, could not bring themselves to utilize the computer output. In fact, they employed their time honored methods and, out of courtesy only, plotted the computer output on their already developed curves. The agreement intrigued them, and eventually they shifted over to computer calculated coordinates. For the uninitiated let me emphasize that full-scale ships' curves were scribed on a huge wooden floor. From these curves, numerous full-size templates were made and used for the construction of steel frames, beams, plates, etc. This has been the standard procedure for eions and changes have been strongly resisted. I lost complete contact with shipbuilding in the intervening years, but this quaint knowledge remained with me. In the European yards I visited (Bergen, Norway and Malmö, Sweden) this time-honored procedure has been abolished, I suppose within the last ten years.

Gone is the football-field-sized mold loft - replaced by a couple of small (20' x 20') rooms still called "the mold loft." Here, the end products of the old mold loft output are coordinated, but the new output consists of paper tapes which control cutting machines in the shops. The lines drawings, now about 1/10 scale rather than full scale, are available on a large drafting table in the "mold loft," but few measurements are lifted from them because very few templates are prepared, having been displaced by computer generated paper tapes which control the cutting machines. Moreover, the computer generated the lines drawings in the first place! The 1/10 scale lines drawing is used sometimes, but not in the traditional way. Many yards had purchased optically controlled cutting machines prior to the acquisition of numerically (paper tape) controlled machines. These optically controlled machines work from a scaled drawing. Since some yards have both kinds of cutters, the computer generated lines drawing is used to guide the optical cutter. Traditionally, the scaled drawings necessary for the optical cutter were prepared from coordinates taken from the full-sized curves available on the old mold loft floor.

Briefly, the new process is the following. Preliminary design procedures yield a set of ships lines drawn to a very small scale. Coordinates (called offsets in the trade) are lifted from these drawings and recorded. Up till now, everything has been done by hand as in the old days when the preliminary offsets would be sent to the mold loft floor for the preparation and fairing of full-size curves from which the final offsets would be lifted.

Now, the preliminary offsets are recorded on punched cards and fed into a computer which generates almost all necessary information for construction of the ship. Immediately after the computer program has generated the faired ships lines and stored the final offsets in memory, the computer program will generate many important ship parameters, e.g., displacement, prismatic coefficient, etc. If these parameters are unacceptable, then back to the drawing board for a modified preliminary design. If they are acceptable, a long comlicated set of computer calculations must be performed. These may be carried out over a period of six weeks or more (not by continuous use of the computer though!). These computer calculations produce results of the following kind:

i) replaces mold-lofting and manual lines fairing with computer offsets (coordinates)
ii) replaces templates with a set of numerical instructions on paper tape and thereby automates plate marking, flame cutting, and production of structural parts
iii) replaces manual operations in shell expansion and production of shell plates
iv) reduces scrap to a minimum by nesting parts on standard plates
v) produces some hydromechanical calculations
vi) produces classification drawings, hull drawings, working drawings
vii) produces a technical data base in which information is available for material ordering, production information (cost, time, weight, etc.).

It is interesting to note that the computer programs for doing all or parts of the above work are being developed in Scandanavia, and that the developers are in competition with each other! There is one program available in the US for naval ship calculations named CASDOS. The writer is unaware of any others. CASDOS must be modified for merchant ship work and also for use on a medium-sized computer since it now requires a huge modern computer, not available to an ordinary shipyard. The Scandinavians are developing their programs for medium-sized computers.

The systems we learned about are AUTOKON, STEERBEAR, and VIKING.

AUTOKON is available through "Shipping Research Services" or "Computas" both of Oslo, Norway, and was developed by Det Norske Veritas ("DnV"), the Norwegian Classification Society together with the Akers group of Norwegian Shipyards. These organizations have recently developed PRELIKON which makes use of the AUTOKON data base and contains subprograms for almost all hydrostatic calculations.

AUTOKON is written in the FORTRAN language, and the system is available for use on computers built by UNIVAC, IBM, Siemens, Burroughs, ICL and CDC. It is claimed that the AUTOKON system has been purchased by US shipyards at Quincy, Mass., Pascagoula, Miss., and Seatrain in New York City and by the St. Johns' yard in Canada.

At the Kockums' Shipyard in Malmö, Sweden, they have developed STEERBEAR which is a system that carried out the calculations available in AUTOKON and PRELIKON. STEERBEAR utilizes a computer language called KOCK which is a powerful set of some 100 basic subroutines in terms of which application-oriented programs can be created. Kock was originally written in that version of the ALGOL language available on the Kockums' SAAB computer. This restricted the usefulness of STEERBEAR I. Modifications have led to STEERBEAR II in which KOCK utilizes standard ALGOL or FORTRAN (the FORTRAN version is being done at the SUN Shipyard in the US and is called the SUN-STEERBEAR system).

Also at Kockums they are developing the co-called Q-system which handles administrative chores like inventory control, planning, payroll, etc. The completed system (early 1972) will integrate certain activities like material ordering, bills of material, etc., with the AUTOKON system so that each system may utilize some information stored in the other. The Q-system will enable people, for example, to find out in minutes whether all material for a works order has been delivered, and if not, when it can be expected.

The third system, called VIKING, is being developed at the Swedish Shipbuilders Computing Center (VDC) at Gothenburg. This center is an independent organization in which the shipyards control most of the stock. VIKING plans to carry out the calculations done by AUTOKON perhaps with some of PRELIKON thrown in. Plans are to modify and extend it until it is as comprehensive as STEERBEAR plus the Q-system. To my knowledge, VIKING is not really in use yet; in fact, the stockholding shipyards do not use it (they do use the VDC which performs many other useful functions besides work on VIKING).

Now, Norwegian AUTOKON was initiating in 1962, Kockums STEERBEAR in 1963, and Swedish Shipbuilders Associations VIKING in 1967. Moreover, the development of VIKING is funded not only by VDC, but also by a grant from the Swedish government. The philosophy behind government support of VIKING is to make use of all available knowledge and produce a super computer-aided ship-design system. Such a philosophy would be more impressive if all Scandinavian countries supported jointly a VIKING type project.

In practice, though, in the single country, Sweden, these goals are not being achieved. The VIKING people do not talk with the STEERBEAR (or the AUTOKON) people. They are simply designing their own super system without utilizing the programming skills and know-how of the veterans in the game (and the veterans say it's lousy).

Meanwhile, the STEERBEAR and AUTOKON groups have years of investment in their systems and must somehow emerge from the red by marketing them in competition with one another. If and when the super VIKING system is completed, it will enter the competition. Let us suppose it is truly superior. It will be relatively easy for a shipyard using AUTOKON or STEERBEAR to change to VIKING. Why? Because the major costs associated with computer-aided shipbuilding stem from the policy decision to go this route. This decision requies a good-sized computer together with the training of yard employees to handle the computer programs, the scrapping of the old lofting and construction procedures, and the requisition of automatic cutting equipment which requires the training of shop employees. Once done, the change to a different computing system is a small matter. Thus, if VIKING is successful, there is the strong possibility of overcoming the competition without making the enormous development and sales investments required of the other systems. Bear in mind that the sales effort involved in selling automated ship design is enormous since the technical staff of a shipyard are generally not acquainted with automated procedures so that the sales effort must train this staff before the staff can evaluate the package which is being sold. Those shipyards who have developed automation will have the rug pulled out from under them. They are penalized for their imagination and daring. No wonder shipyards are conservative organizations!

Be that as it may, what other advantages are available in automation? Small shipyards can make use of the large yards' automated facilities even to the extent of utilizing the automatic cutting procedures. Thus, the elements of a small ship may be prepared at a large yard. I believe this procedure is necessary in order to make the CAD programs most effective. Otherwise, the programming staff of the large yard will not remain familiar with the complex programming process since a completely new ship is a rare occurrence, e.g., every one or two years. Then there is economics.

Are these new procedures cost effective? No definitive answers were available. Kockums, for instance, remains in the red, but attributes this to the huge costs associated with conversion to CAD, development costs, modernization and enlargement of the yard,, and to contracts-in-hand requiring them to build different kinds of ships. Now they are involved in a long range program of building single class ships - supertankers, what else!? They expect to become profitable in 1972. Nevertheless, it is my opinion that automated shipbuilding is the only route to follow. To reach the end of this route successfully may take another generation. Philosophy, education and training must accompany the travelers. Research programs in CAD in schools of naval architecture must be pursued, and here, federal support must be made available. Little research of this kind is now being done in schools of naval architecture, but is being done in other places. How, then, can newly trained naval architects be expected to support CAD if their own professors are not personally involved in it?

At Imperial College, London, a group is investigating the use of graphics in preliminary design. At Admiralty Research Laboratory (ARL) near London another group is carrying out a similar project. The first is for commercial ship building. The second for the Admiralty, so naturally they don't communicate! We remind the reader that the Scandinavian systems assume preliminary design is done by hand and that the Scandinavians are not working on such programs. The ARL project was described in some detail by Mandel in ESN-24-9, 30 Sept. 1970.

At the University of Nottingham, England, a system called SAMMIE has been developed which automates "work studies," e.g., produces work place layouts, automates work synthesis for hand assembly tasks, produces detailed analyses of work tasks, etc.

Very little effort is expended on statistical techniques. No one admitted to using computerized quality control techniques, or to carrying out statistical analyses of the masses of data which have been and are being collected in shipyard building programs.

In closing, we recall with pleasure our visit to the Kockums Yard in Malmö, Sweden. It was like a dream world for this visitor who hadn't looked in on a shipyard for almost ten years.